ETRX35x ZIGBEE® MODULES

PRODUCT MANUAL

telegesis

Table of Contents

Image not shown actual size; enlarged to show detail.

The Telegesis ETRX351 and ETRX357 modules are low power 2.4GHz ZigBee modules, based on the latest Ember EM351 and EM357 single chip ZigBee^{TM} / IEEE802.15.4 solutions.

They have been designed to be integrated into any device without the need for RF experience and expertise. Utilizing the EmberZNet ZigBee stack, the ETRX35x enables you to add powerful wireless networking capability to your products and quickly bring them to market.

The module's unique AT-style command line interface allows designers to quickly integrate ZigBee technology without complex software engineering. For custom application development the ETRX35x series integrates with ease into Ember's InSight development environment.

Module Features

- Small form factor, SMT module 25mm x 19mm
- Side Castellations for easy soldering and inspection
- 2 antenna options: Integrated chip antenna or U.FL coaxial connector
- Industry's first ARM® Cortex-M3 based family of ZigBee modules
- Industry standard JTAG Programming and real time network level debugging via the Ember InSight Port
- 192kB (ETRX357) and 128kB (ETRX351) flash and 12kbytes of RAM
- Lowest Deep Sleep Current of sub 1µA and multiple sleep modes
- Wide supply voltage range (2.1 to 3.6V)
- 32.768kHz watch crystal can be added externally
- Module ships with standard Telegesis AT-style command interface based on the ZigBee PRO feature set
- Can act as an End Device, Router or Coordinator
- 24 general-purpose I/O lines including analogue inputs (all GPIOs of the EM35x are accessible)
- Firmware upgrades via serial port or over the air (password protected)
- Hardware supported encryption (AES-128)
- CE and FCC compliance, FCC modular approval pending
- Operating temperature range: -40$^{°}$C to +85$^{°}$C
- Long Range version with a link budget of up to 124dB available in the same form factor

Radio Features

- Based on the Ember EM351 and EM357 single chip ZigBee^{TM} / IEEE802.15.4 solutions
- 2.4GHz ISM Band
- 250kbit/s over the air data rate
- 16 channels (IEEE802.15.4 Channel 11 to 26)
- +3dBm output power (+8dBm in boost mode)
- High sensitivity of -100dBm (-101dBm in boost mode) typ. @ 1% packet error rate
- RX Current: 26mA, TX Current: 31mA at 3dBm
- Robust Wi-Fi and Bluetooth coexistence

Suggested Applications

- AMR – ZigBee Smart Energy applications
- Wireless Alarms and Security
- Home/Building Automation
- Wireless Sensor Networks
- M2M Industrial Controls
- Lighting and ventilation control
- Remote monitoring
- Environmental monitoring and control

Development Kit

- New Development kit containing everything required to set up a mesh network quickly and evaluate range and performance of the ETRX35x and its long range version.
- AT-style software interface command dictionary can be modified for high volume customers.
- Custom software development available upon request.

Example AT-Style Commands

AT+BCAST   Send a Broadcast
AT+UCAST:<address>   Send a Unicast
AT+EN   Establish PAN network
AT+JN   Join PAN

At power-up the last configuration is loaded from non-volatile S-Registers, which can eliminate the need for an additional host controller.

1   Introduction

This document describes the Telegesis ETRX351 and ETRX357 ZigBee® modules which have been designed to be easily integrated into another device and to provide a fast, simple and low cost wireless mesh networking interface.

The Telegesis ETRX3 series modules are based on the Ember ZigBee® platform consisting of the single chip EM351 or EM357 combined with the ZigBee PRO compliant EmberZNet meshing stack.   Integration into a wide range of applications is made easy using a simple AT style command interface and advanced hardware design.

The configurable functionality of the Telegesis AT Commandset often allows the ETRX3 series ZigBee modules to be used without an additional host microcontroller saving even more integration time and costs.   In addition to the Telegesis AT Commandset, the ETRX351 and ETRX357 modules can be used with custom-built firmware and they represent an ideal platform for custom firmware development in conjunction with the Ember development kits.

No RF experience or expertise is required to add this powerful wireless networking capability to your products. The ETRX351 and ETRX357 offer fast integration opportunities and the shortest possible time to market for your product.

1.1   Hardware Description

The main building blocks of the ETRX351 and ETRX357 are the single chip EM351 and EM357 from Ember, a 24MHz reference crystal and RF front-end circuitry optimized for best RF performance. The modules are available with on-board antenna or alternatively a U.FL connector for attaching external antennae. Modules with the U.FL connector are identified by the "HR" suffix.

The integrated antenna is an Antenova Rufa, and details of the radiation pattern etc are available from the Antenova website [5].

Module	Chip	Flash	RAM
ETRX351	EM351	128kB	12kB
ETRX351HR	EM351	128kB	12kB
ETRX357	EM357	196kB	12kB
ETRX357HR	EM357	196kB	12kB

Table 1: Memories

The ETRX351 and ETRX357 are used for ZigBee® (www.zigbee.org) applications. If you wish to create your own custom firmware, and not use the pre-loaded Telegesis AT-Command interface, you will need the InSight toolchain, consisting of InSight Desktop™ together with a comprehensive integrated development environment (IDE) and C-language compiler toolchain from Ember. The Ember development environment is not suitable for an 802.15.4-only application that does not use the ZigBee layer.

2   Product Approvals

The ETRX351 and ETRX357 have been designed to meet all national regulations for world-wide use. In particular the following certifications have been obtained:

2.1   FCC Approvals

The Telegesis ETRX351 and ETRX357 with integrated Antenna as well as the ETRX351HR and the ETRX357HR including the antennae listed in Table 2. Approved Antennae

will be tested to comply with FCC CFR Part 15 (USA). The devices meet the requirements for modular transmitter approval as detailed in the FCC public notice DA00.1407.transmitter.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC ID: <TBD>

This module complies with the USA SAR requirements and is not intended to be operated within 20cm of the body. The following statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF exposure compliance:

"WARNING: To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operations at closer distances than this are not recommended."

Item	Part No.	Manufacturer	Type	Gain
1	tbd	tbd	tbd	tbd

Table 2. Approved Antennae

While the applicant for a device into which the ETRX351 (ETRX357) or ETRX351HR (ETRX357HR) with an antenna listed in Table 2 is installed is not required to obtain a new authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for the end product.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Telegesis (UK) Ltd. may void the user's authority to operate the equipment.

When using the ETRX351HR and ETRX357HR with approved antennae, it is required to prevent end-users from replacing them with non-approved ones.

2.1.1   FCC Labelling Requirements

When integrating the ETRX351, ETRX357, ETRX351HR and ETRX357HR into a product if must be ensured that the FCC labelling requirements are met. This includes a clearly visible label on

the outside of the finished product specifying the Telegesis FCC identifier (**FCC ID: <TBD>**) as well as the notice above. This exterior label can use wording such as **"Contains Transmitter Module FCC ID: <TBD>"** or **"Contains FCC ID: <TBD>"** although any similar wording that expresses the same meaning may be used.

2.2 European Certification

The ETRX351, ETRX357, ETRX351HR and ETRX357HR will be certified to the following standards:

- Radio: EN 300 328 v1.7.1 (10/2006)
- EMC: EN 301 489-17 v2.1.1 (09/2008)
- Safety: EN 60950-1:2006

  The ETRX351HR and ETRX357HR will be tested with the antennae listed in Table 2. Approved Antennae

.

CE0681 EC-R&TTE Certificated

If the ETRX351, ETRX357, ETRX351HR or ETRX357HR module is incorporated into an OEM product, the OEM product manufacturer must ensure compliance of the final product to the European Harmonised EMC, and low voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in the R&TTE Directive. The final product must not exceed the specified power ratings, antenna specifications and installation requirements as specified in this user manual. If any of these specifications are exceeded in the final product then a submission must be made to a notified body for compliance testing to all of the required standards.

The 'CE' marking must be applied to a visible location on any OEM product. For more information please refer to http://ec.europa.eu/enterprise/faq/ce-mark.htm. Customers assume full responsibility for learning and meeting the required guidelines for each country in their distribution market.

2.3 Declarations of Conformity

Telegesis (UK) Ltd will issue Declarations of Conformity for all ETRX3 series ZigBee® RF Modules, which cover Radio Emissions, EMC and Safety. These documents will be available from our website or on request

2.4 IEEE 802.15.4

IEEE 802.15.4 is a standard for low data rate, wireless networks (raw bit-rate within a radio packet of 250kbps @2.4GHz) which focuses on low cost, low duty cycle, long primary battery life applications as well as mains-powered applications. It is the basis for the open ZigBee® Protocol.

2.5 The ZigBee® Protocol

The ZigBee® Protocol is a set of standards for wireless connectivity for use between any devices over short to medium distances. The specification was originally ratified in December 2004, paving the way for companies to start making low-power networks a reality.

ZigBee® uses an IEEE 802.15.4 radio specification running on the 2.4GHz band, plus three additional layers for networking, security and applications. What makes the specification unique is its use of a mesh network architecture which, in bucket chain style, passes data from one node to the next until it lands at its destination. The network is self-healing and adapts its routing as link quality changes or nodes move. Furthermore, nodes can be defined as End Devices which do not act as routers, but can therefore be put into a low-power sleep state.

The enhanced version of the ZigBee® standard (or ZigBee® 2006) was released in December 2006, adding new features and improvements to the only global wireless communication standard enabling the development of easily deployable low-cost, low-power, monitoring and control products for homes, commercial buildings and industrial plant monitoring. In 2007 the ZigBee Alliance introduced the PRO featureset which offers advantages over earlier versions, including

- Truly self healing mesh networking
- Messages can now travel up to 30 hops
- Source-Routing for improved point to multipoint message transmission
- Improved security including Trust-Centre link keys
- New message types and options

The Telegesis AT Commandset, which by default ships on all ETRX3 series products is based on the ZigBee PRO featureset. For more information on the Telegesis AT Commandset please refer to the separate documentation at www.telegesis.com.
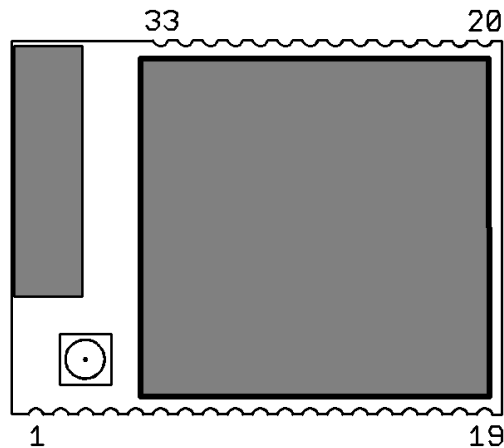
3   Module Pinout

Figure 1: ETRX3 series Module Pinout (top view)

The table below gives details about the pin assignment for direct SMD soldering of the ETRX3 series modules to the application board. For more information on the alternate functions please refer to [2]. Also refer to the Telegesis AT Commandset documentation to understand how the pre-programmed firmware makes use of the individual I/Os.

All GND pads are connected within the module, but for best RF performance all of them should be grounded externally.

ETRX35x Pad	Function	EM35x Pin	Alternate Functions
1	GND	GND	
2	PC5 {1}	11	TX_ACTIVE
3	PC6	13	OSC32B, nTX_ACTIVE
4	PC7	14	OSC32A, OSC32_EXT
5	PA7 {4}	18	TIM1C4
6	PB3 {2}	19	SC1nCTS, SC1SCLK, TIM2C3
7	nReset	12	
8	PB4 {2}	20	TIM2C4, SC1nRTS, SC1nSSEL
9	PA0	21	TIM2C1, SC2MOSI
10	PA1	22	TIM2C3, SC2SDA, SC2MISO
11	PA2	24	TIM2C4, SC2SCL, SC2SCLK
12	PA3	25	SC2nSSEL, TRACECLK, TIM2C2
13	GND	GND	
14	PA4	26	ADC4, PTI_EN, TRACEDATA
15	PA5 {3}	27	ADC5, PTI_DATA, nBOOTMODE, TRACEDATA3
16	PA6 {4}	29	TIM1C3
17	PB1	30	SC1MISO, SC1MOSI, SC1SDA, SC1TXD, TIM2C1
18	PB2	31	SC1MISO, SC1MOSI, SC1SCL, SC1RXD, TIM2C2
19	GND	GND	
20	GND	GND	

ETRX35x Pad	Function	EM35x Pin	Alternate Functions
21	JTCK	32	SWCLK
22	PC2	33	JTDO, SWO
23	PC3	34	JTDI
24	PC4	35	JTMS, SWDIO
25	PB0	36	VREF, IRQA, TRACECLK, TIM1CLK, TIM2MSK
26	PC1	38	ADC3, SWO, TRACEDATA0
27	PC0 {4}	40	JRST, IRQD, TRACEDATA1
28	PB7 {4}	41	ADC2, IRQC, TIM1C2
29	PB6 {4}	42	ADC1, IRQB, TIM1C1
30	PB5	43	ADC0, TIM2CLK, TIM1MSK
31	GND	GND	
32	Vcc	Vcc	
33	GND	GND	

Table 3. Pin Information

Notes:

{1} PC1 is not usable on the long range version of the ETRX35x as this GPIO is used as TX_ACTIVE to control the external RF frontend.

{2} When using the Telegesis AT Commandset, RTS/CTS handshaking is selectable in firmware. See the AT Command Manual.

{3} If PA5 is driven low at power-up or reset the module will boot up in the bootloader

{4} PA6, PA7, PB6, PB7 and PC0 can drive high current (see section 9)
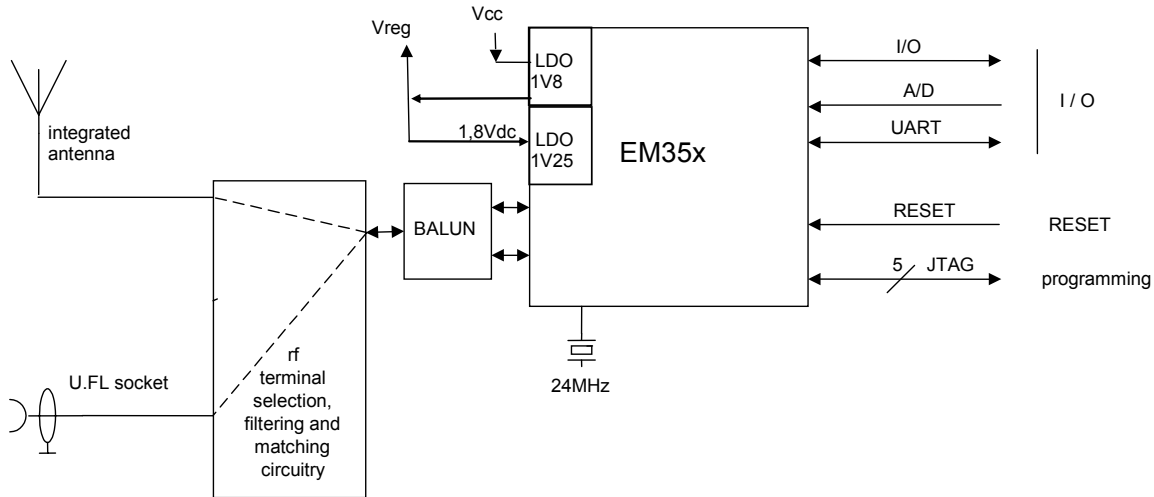
4   Hardware Description

Figure 2: Hardware Diagram

The ETRX351 and ETRX357 are based on the Ember EM351 and EM357 respectively. The EM351 and EM357 are fully integrated 2.4GHz ZigBee transceivers with a 32-bit ARM® Cortex M3™ microprocessor, flash and RAM memory, and peripherals.

The industry standard serial wire and JTAG programming and debugging interfaces together with the standard ARM system debug components help to streamline any custom software development.

In addition to this a number of MAC functions are also implemented in hardware to help maintaining the strict timing requirements imposed by the ZigBee and IEEE802.15.4 standards.

The new advanced power management features allow faster wakeup from sleep and new power down modes allowing this 3rd generation module to offer a longer battery life than any 2nd generation modules on the market.

The EM35x has fully integrated voltage regulators for both required 1.8V and 1.25V supply voltages. The voltages are monitored (brown-out detection) and the built in power-on-reset circuit eliminates the need for any external monitoring circuitry. A 32.768kHz watch crystal can be connected externally to pads 3 and 4 in case more accurate timing is required.

4.1   Hardware Interface

All gpio pins of the EM351 or EM357 are accessible on the module's pads. Whether signals are used as general purpose I/Os, or assigned to a peripheral function like ADC is set by the firmware. When using the Telegesis AT Commandset please refer to the AT Commandset manual for this information and when developing custom firmware please refer to the EM35x datasheet.

5   Firmware Description

The modules will be pre-loaded with a standalone bootloader which supports over-the-air bootloading as well as serial bootloading of new firmware.

In order to enter the standalone bootloader using a hardware trigger pull PA5 to ground and power-cycle the module. To avoid entering the standalone bootloader unintentionally make sure not to pull this pin down during boot-up unless the resistance to ground is >10kΩ. (A pull-up is not required).

In addition to the standalone bootloader the modules also contain the current release of the Telegesis AT-style command interface as described in the Telegesis AT command dictionary and the Telegesis user guide. Check www.telegesis.com for updates. Each module comes with a unique 64-bit 802.15.4 identifier which is stored in non-volatile memory. The commands and responses pass through the serial port of the ETRX35x as ASCII text, so a simple terminal application will usually suffice. We provide Telegesis Terminal but it is not an essential feature.

The pre-loaded AT-style command interface firmware is based on the latest EmberZNet meshing stack which implements routers/coordinators as well as (sleepy) end devices. [End devices have no routing responsibility and therefore are allowed to go to sleep, whilst still being able to send and receive messages via a parent router. In addition to a classical (sleepy) end device the module firmware also supports mobile (sleepy) end devices capable of changing their parent quickly whenever they change their position within the network.]

A router is typically a mains powered device whilst a sleepy end device (SED) can be battery powered.

The module is also able to act as a PAN coordinator and Trust Centre through external host control. The AT style command line supplies all the tools required to set up and manage a ZigBee network by allowing easy access to the low-level functionality of the stack.

The Telegesis firmware uses the meshing and self healing EmberZNet PRO stack to overcome many of the limitations of the tree network topology of the ZigBee® 2006 stack by using the ZigBee PRO featureset.

The Telegesis firmware also allows low-level access to physical parameters such as channel and power level. Parameters that define the functionality of the ETRX35x module and also allow standalone functionality are saved in non-volatile memory organised in so-called S-Registers. The SPI and I2C buses are not supported by the current firmware release, but can be used with custom firmware.

5.1   Custom Firmware

For high volume customers the firmware can be customised on request. Customers can use the ETRX35x module as hardware only and develop their own firmware based on the EmberZNet stack. In order to develop custom firmware Insight Desktop™ is required together with a comprehensive integrated development environment (IDE) and C-language compiler toolchain from Ember.

5.2   Software Interface

Using the default firmware the ETRX35x is controlled using a simple AT-style command interface and (mostly) non-volatile S-Registers. In order to get a full listing of all the available AT-Commands, please refer to the AT command dictionary document which corresponds to the firmware revision you intend to use.

In addition to the command dictionary there are user guides explaining the features of the firmware in more detail. If you need to find out which firmware resides on your module simply type "**ATI**" followed by a carriage return and you will be prompted with the module's manufacturing information.

The Development Kit manual describes how to upgrade the firmware either via a serial link or over the air.

6 Absolute Maximum Ratings

Supply: 3.6V
Inputs: -0.3V to Vcc + 0.3V
Operating temperature: -40 to 85°C

No.	Item	Symbol	Absolute Maximum Ratings	Unit
1	Supply voltage	V_{CC}	-0.3 to +3.6	Vdc
2	Voltage on any I/O[11:0] , SIF_CLK, SIF_MISO, SIF_MOSI, SIF_LOADB, RESET	V_{in}	-0.3 to V_{CC} +0.3	Vdc
3	Storage temperature range	T_{stg}	-40 to +105	°C
4	Operating temperature range	T_{op}	-40 to +85	°C
5	Input RF level	P_{max}	15	dBm
6	ESD on any pin {1} according to Human Body Model (HBM) circuit description	V_{THHBM}	±2	kV
7	Reflow temperature	T_{Death}	Please refer to chapter 13	°C

Table 4. Absolute Maximum Ratings

Note:

{1} Input must be current limited to the value specified.

The absolute maximum ratings given above should under no circumstances be violated. Exceeding one or more of the limiting values may cause permanent damage to the device.

Caution! ESD sensitive device. Precautions should be used when handling the device in order to prevent permanent damage.

7 Recommended Operating Conditions

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Supply voltage		V_{CC}	2.1		3.6	Vdc
2	RF Input Frequency		f_C	2405		2480	MHz
3	RF Input Power		p_{IN}			0	dBm
4	Operating temperature range		T_{op}	-40		+85	°C

Table 5. Recommended Operating Conditions

8   DC Electrical Characteristics

V_{CC} = 3.0V, T_{AMB} = 25°C, NORMAL MODE unless otherwise stated

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Module supply voltage		V_{CC}	2.1		3.6	Vdc
2	Quiescent current, internal RC oscillator disabled		I_{SLEEP}		0.4		µA
3	Quiescent current, internal RC oscillator enabled		I_{SLEEP}		0.8		µA
4	Quiescent current, including 32.768kHz oscillator		I_{SLEEP}		1.3		µA
5	Transmit current consumption	at +3dBm module output power	I_{TXVCC}		31		mA
6	Transmit Current consumption BOOST MODE	at +8dBm module output power	I_{TXVCC}		39		mA
7	Transmit current consumption	at +0dBm module output power	I_{TXVCC}		28.5		mA
8	Transmit current consumption	at min. module output power	I_{TXVCC}		23.5		mA
9	Receive current consumption	Total, 12MHz clock speed	I_{RX}		26		mA
10	Receive current consumption	Total, 24MHz clock speed	I_{RX}		27		mA
11	Receive current consumption BOOST MODE	Total, 12MHz clock speed	I_{RX}		27		mA
12	Receive current consumption BOOST MODE	Total, 24MHz clock speed	I_{RX}		28		mA
13	MCU, RAM and flash, radio off	12MHz clock speed	I_{MCU}		7		mA
14	MCU, RAM and flash, radio off	24MHz clock speed	I_{MCU}		8		mA
15	Serial Controller	Max data rate	I_{SC}		0.2		mA
16	Timer	Max clock rate	I_{TMR}		0.25		mA
17	ADC	Max sample rate	I_{ADC}		1.1		mA
18	Wake time from deep sleep	From wakeup event to 1st instruction			100		µs
19	Shutdown time	From last instruction into deep sleep			5		µs

Table 6. DC Electrical Characteristics

Please Note: The average current consumption during operation is dependent on the firmware and the network load, therefore these figures are given in the command dictionary of the respective firmware.

9   Digital I/O Specifications

The digital I/Os of the ETRX35x module

V_{CC} = 3.0V, T_{AMB} = 25°C, NORMAL MODE unless otherwise stated

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	**Typ**	**Max**	
1	Low Schmitt switching threshold	Schmitt input threshold going from high to low	V_{SWIL}	0.42 x V_{CC}		0.5 x V_{CC}	Vdc
2	High Schmitt switching threshold	Schmitt input threshold going from low to high	V_{SWIH}	0.62 x V_{CC}		0.8 x V_{CC}	MHz
3	Input current for logic 0		I_{IL}			-0.5	µA
4	Input current for logic 1		I_{IH}			0.5	µA
5	Input Pull-up resistor value		R_{IPU}	24	29	34	kΩ
6	Input Pull-down resistor value		R_{IPD}	24	29	34	kΩ
7	Output voltage for logic 0	I_{OL} = 4mA (8mA) for standard (high current) pads	V_{OL}	0		0.18 x V_{CC}	V
8	Output voltage for logic 1	I_{OH} = 4mA (8mA)for standard (high current) pads	V_{OH}	0.82 x V_{CC}		V_{CC}	V
9	Output Source Current	Standard current pad	I_{OHS}			4	mA
10	Output Sink current	Standard current pad	I_{OLS}			4	mA
11	Output Source Current	High current pad	I_{OHH}			8	mA
12	Output Sink current	High current pad	I_{OLH}			8	mA
13	Total output current		I_{OH} + I_{OL}			40	mA

Table 7. Recommended Operating Conditions

10 A/D Converter Characteristics

The ADC is a first-order sigma-delta converter. For additional information on the ADC please refer to section 10 of the EM35x datasheet.

No.	Item	
1	A/D resolution	Up to 12 bits
2	A/D sample time for 5-bit conversion	5.33µs
3	A/D sample time for 12-bit conversion	682µs
4	Reference Voltage	1.25V or Vcc

Table 8. A/D Converter Characteristics

11 AC Electrical Characteristics

V_{CC} = 3.0V, T_{AMB} = 25°C, NORMAL MODE measured at 50Ω terminal load connected to the U.FL socket

No.	Receiver	Value			Unit
		Min	Typ	Max	
1	Frequency range	2400		2500	MHz
2	Sensitivity for 1% Packet Error Rate (PER)		-100	-94	dBm
3	Sensitivity for 1% Packet Error Rate (PER) BOOST MODE		-101	-95	dBm
4	Saturation (maximum input level for correct operation)	0			dBm
5	High-Side Adjacent Channel Rejection (1% PER and desired signal –82dBm acc. to [1])		35		dB
6	Low-Side Adjacent Channel Rejection (1% PER and desired signal –82dBm acc. to [1])		35		dB
7	2nd High-Side Adjacent Channel Rejection (1% PER and desired signal –82dBm acc. to [1])		43		
8	2nd Low-Side Adjacent Channel Rejection (1% PER and desired signal –82dBm acc. to [1])		43		
9	Channel Rejection for all other channels (1% PER and desired signal –82dBm acc. to [1])		40		dB
10	802.11g rejection centred at +12MHz or –13MHz (1% PER and desired signal –82dBm acc. to [1])		35		dB
11	Co-channel rejection (1% PER and desired signal –82dBm acc. to [1])		-6		dBc
12	Relative frequency error (2x40ppm required by [1])	-120		120	ppm
13	Relative timing error (2x40ppm required by [1])	-120		120	ppm
14	Linear RSSI range	40			dB
15	Output power at highest power setting NORMAL MODE BOOST MODE	0	3 8		dBm
16	Output power at lowest power setting		-32		dBm
17	Error vector magnitude as per IEEE802.15.4		5	14	%
18	Carrier frequency error	-40		40	ppm
19	PSD mask relative 3.5MHz distance from carrier	-20			dB
20	PSD mask absolute 3.5MHz distance from carrier	-30			dBm

Table 9. AC Electrical Characteristics

Please Note: For the relationship between EM35x power settings and module output power please relate to chapter 11.1 of this document. When developing custom firmware the output power settings described in this document relate directly to the EM35x power settings accessible via the Ember stack API.

No.	Synthesiser Characteristics	Limit			Unit
		Min	Typ	Max	
22	Frequency range	2400		2500	MHz
23	Frequency resolution		11.7		kHz
24	Lock time from off state, with correct VCO DAC settings			100	µs
25	Relock time, channel change or Rx/Tx turnaround			100	µs
26	Phase noise at 100kHz offset		-71dBc/Hz		
27	Phase noise at 1MHz offset		-91dBc/Hz		
28	Phase noise at 4MHz offset		-103dBc/Hz		
29	Phase noise at 10MHz offset		-111dBc/Hz		

Table 10. Synthesiser Characteristics

No.	Power On Reset (POR) Specifications	Limit			Unit
		Min	Typ	Max	
30	V_{CC} POR release	0.62	0.95	1.2	Vdc
31	V_{CC} POR assert	0.45	0.65	0.85	Vdc

Table 11. Power On Reset Specifications

No.	nRESET Specifications	Limit			Unit
		Min	Typ	Max	
32	Reset Filter Time constant	2.1	12	16	µs
33	Reset Pulse width to guarantee a reset	26			µs
34	Reset Pulse width guaranteed not to cause reset	0		1	µs

Table 12. nReset Specifications

11.1 TX Power Characteristics

The diagrams below show the typical output power and module current in dependency on module supply voltage and EM35x power setting in NORMAL MODE and BOOST MODE.

t.b.d

Figure 3. Output Power vs. Power Setting

t.b.d

Figure 4. Output Power vs. Power Setting

t.b.d

Figure 5. Module Current vs. Power Setting

t.b.d

Figure 6. Output Power vs. Power Setting (BOOST MODE)

t.b.d

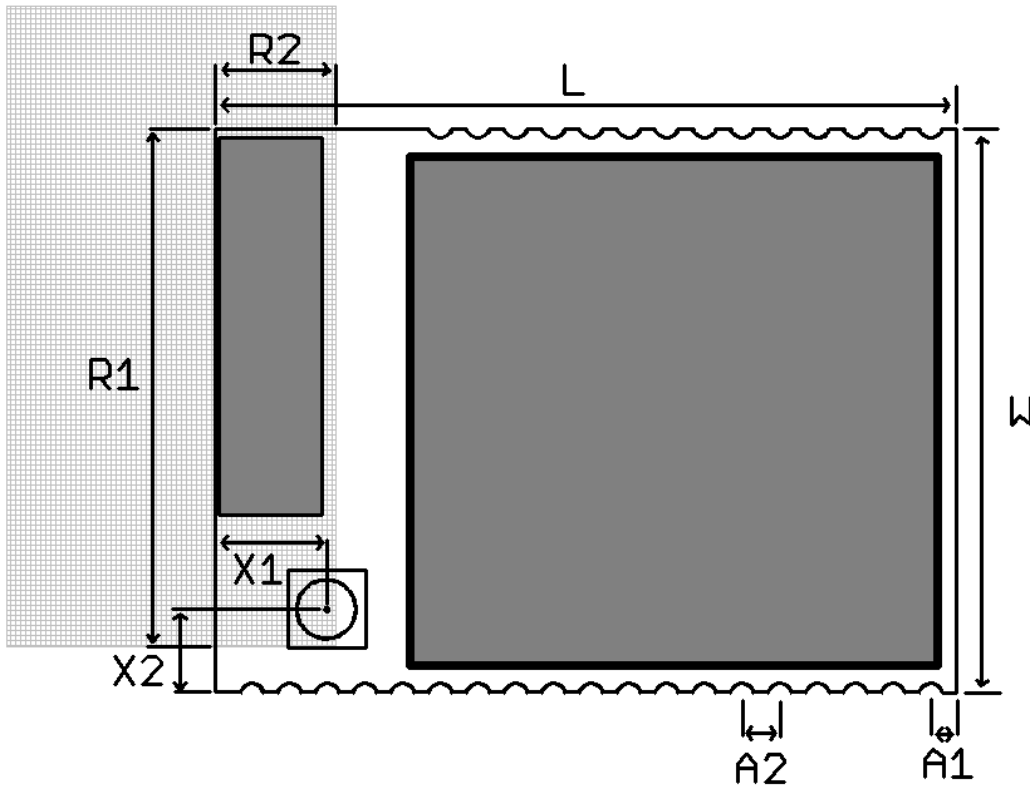**Figure 7. Module Current vs. Power Setting (BOOST MODE)**

12 Physical Dimensions

Figure 8. ETRX3 Physical Dimensions

Symbol	Explanation	Distance
L	Length of the module	25.0mm
W	Width of the module	19.0mm
H	Height of the module	3.0mm
A1	Distance centre of pad PCB edge	0.9mm
A2	Pitch	1.27mm
R1	Keep-out Zone from corner of PCB	17.5mm
R2	Keep-out Zone from corner of PCB	4.1mm
X1	Distance centre of Antenna connector PCB edge	3.8mm
X2	Distance centre of Antenna connector PCB edge	2.8mm

Table 13. ETRX3 Physical Dimensions

For ideal RF performance when using the on-board antenna, the antenna should be located at the corner of the carrier PCB. There should be no components, tracks or copper planes in the "keep-out" area which should be as large as possible. When using the U.FL RF connector the "keep-out" area doesn't have to be kept. **NB**: The module transmit/receive range will depend on the antenna used and also the housing of the finished product.

13 Soldering Temperature Time Profile (for reflow soldering)

13.1 For Leaded Solder
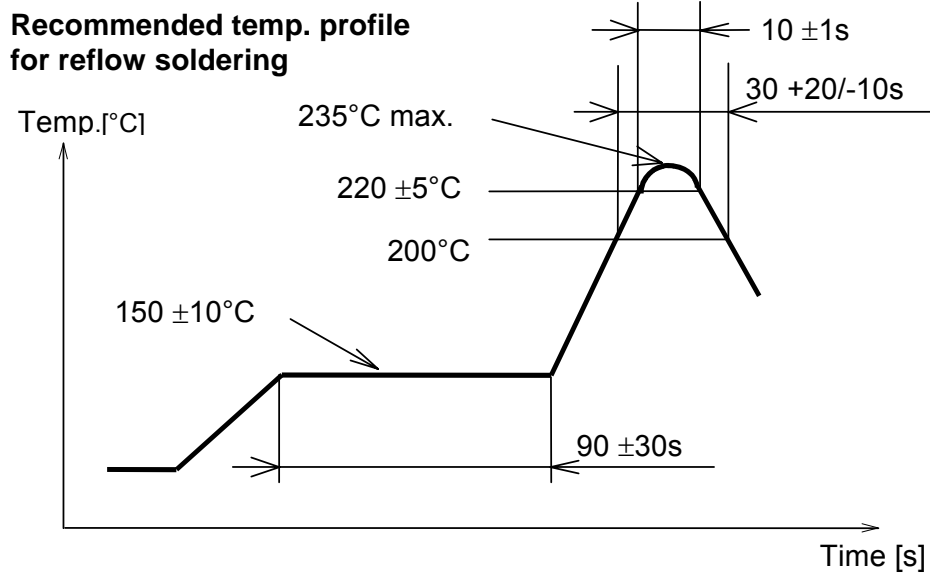
Recommended temp. profile for reflow soldering

Figure 9. Temperature Profile for Lead Solder

13.2 For Lead-free Solder

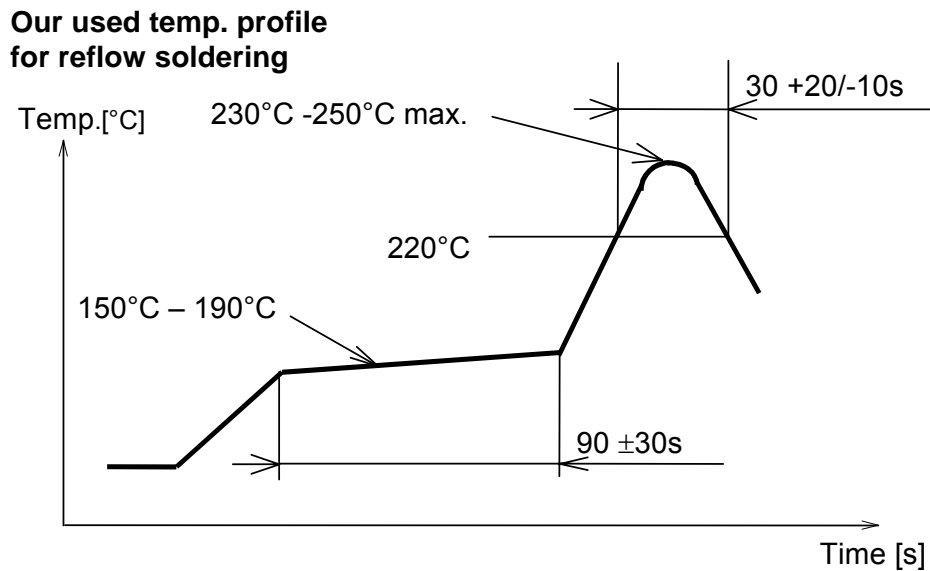**Our used temp. profile for reflow soldering**

Figure 10. Temperature Profile for Lead-free Solder

NB:
Maximum Reflow Cycles: 2
Opposite-side reflow is prohibited due to the module's weight. (i.e. you must not place the module on the bottom / underside of your pcb and re-flow).

---

14 Product Label Drawing

Figure 11. Product Label

The label dimensions are 17.0mm x 17.0 mm. The label will withstand temperatures used during reflow soldering.

Imprint	Description
ETRX357HR-LR	Module Order code
000001	Indication for the serial number.
090101	Production Date Code in the format YYMMDD, e.g. 090602
01	Indication for batch number
02	Indication for the hardware revision
FCC ID: 123456789	FCC ID code for this product
2D-Barcode	Information in the Datamatrix 2D-Barcode are the serial number [6 characters], the Part-Order code [12 characters], identifier for the batch number [2 characters], the identifier for the hardware release [2 characters] and the production date code in the format Year-Month-Day [6 characters], separated by a semicolon.

Table 14. ETRX3xx Label Details

15 Recommended Footprint

In order to surface mount a ETRX3 series module, we recommend that you use pads which are 1mm wide and 1.2mm high. You must retain the "keep-out" zone shown in section 12, and ensure that this area is free of copper tracks and/or copper planes/layers.

You must also ensure that there is no exposed copper on your layout which may contact with the backside of the ETRX3 series module.

For best RF performance it is required to provide good ground connections to the ground pads of the module. It is recommended to use multiple vias between each ground pad and a solid ground plane to minimize inductivity in the ground path.
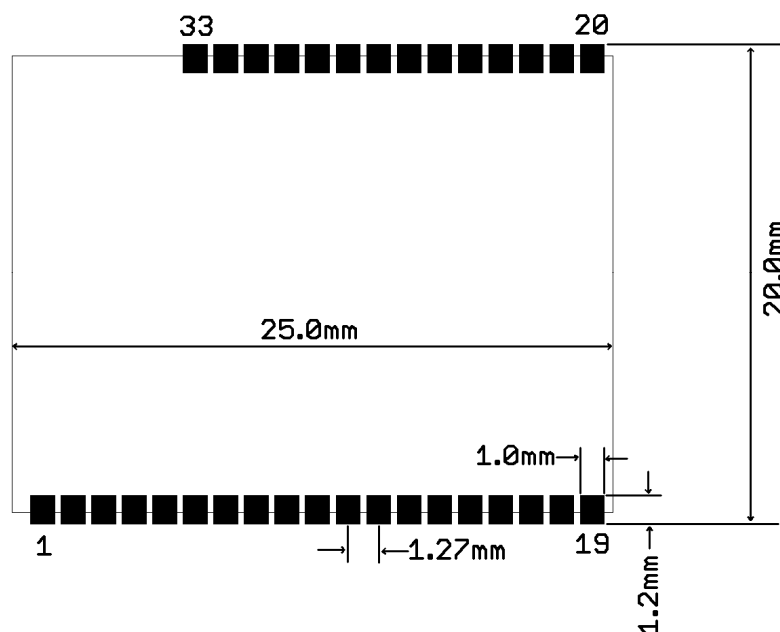
Figure 12. Recommended Footprint

The land pattern dimensions above serve as a guideline.

We recommend that you use the same pad dimensions for the solder paste screen as you have for the copper pads. However these sizes and shapes may need to be varied depending on your soldering processes and your individual production standards. We recommend a paste screen thickness of 120µm to 150µm.

Although the undersides of the ETRX3 series modules are fully coated, no exposed copper, such as through-hole vias, planes or tracks on your board component layer, should be located below the ETRX3 series module in order to avoid 'shorts'. In cases where a exposed track or through hole via has to be located under the module it must be kept away from ETRX3 series module's via holes. All ETRX3 series modules use a multilayer PCB containing an inner RF shielding ground plane, therefore there is no need to have an additional copper plane directly under the ETRX3 series module.

15.1 Example carrier board

Since the RF performance of the module with the on board antenna is strongly dependent on the proper location of the module on its carrier board, Figure 13 shows the reference carrier board which was used during testing by Telegesis.
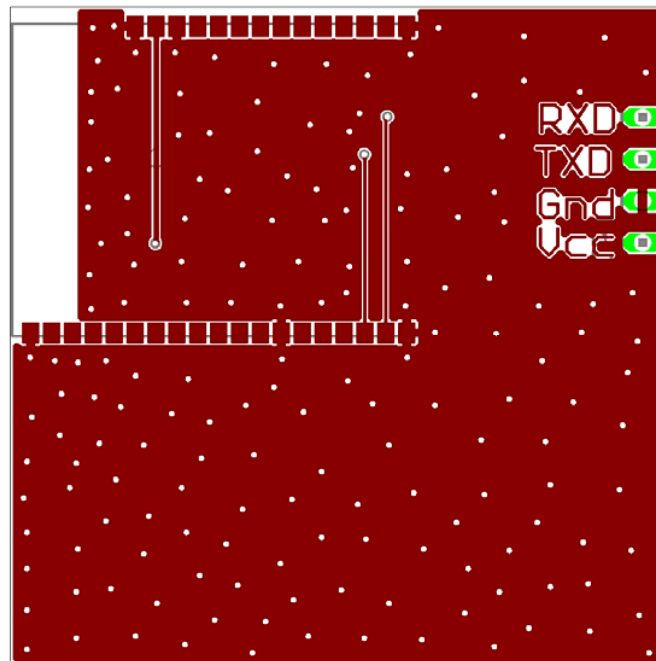

Figure 13. Reference Board

For best performance it is recommended to locate the antenna towards the corner of the carrier board and to respect the recommended keep-out areas as described in section 12.

Finally to provide a good reference ground to the on board antenna, the carrier board should have a ground plane spanning no less than 40 x 40mm. In many cases a smaller ground plane will suffice, but a degradation in radio performance could be the result.

16 Reliability Tests

The measurements will be conducted after the module has been exposed to standard room temperature and humidity for 1 hour.

No	Item	Limit	Condition
1	Vibration test	Electrical parameter should be in specification	a) Freq.:10~50Hz,Amplitude:1.5mm a) 20min. / cycle,1hrs. each of XYZ axis b) Freq.:30~100Hz, 6G b) 20min. / cycle,1hrs. each of XYZ axis
2	Shock test	the same as the above	Dropped onto hard wood from height of 50cm for 3 times
3	Heat cycle test	the same as the above	-40°C for 30min. and +85°C for 30min.; each temperature 300 cycles
4	Moisture test	the same as the above	+60°C, 90% RH, 300h
5	Low temp. test	the same as the above	-40°C, 300h
6	High temp. test	the same as the above	+85°C, 300h

Table 15. Reliability Tests

17 Application Notes

17.1 Safety Precautions

These specifications are intended to preserve the quality assurance of products as individual components.

Before use, check and evaluate their operation when mounted on your products. Abide by these specifications when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, then provide the following failsafe functions as a minimum:

(1)   Ensure the safety of the whole system by installing a protection circuit and a protection device.

(2)   Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a single fault causing an unsafe status.

17.2 Design Engineering Notes

(1)   Heat is the major cause of shortening the life of these products. Avoid assembly and use of the target equipment in conditions where the product's temperature may exceed the maximum allowable.

(2)   Failure to do so may result in degrading of the product's functions and damage to the product.

(3)   If pulses or other transient loads (a large load applied in a short time) are applied to the products, before use, check and evaluate their operation when assembled onto your products.

(4)   These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their

performance and reliability under the said special conditions carefully, to determine whether or not they can be used in such a manner.

(5) In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash.

(6) In direct sunlight, outdoors, or in a dusty environment

(7) In an environment where condensation occurs.

(8) In an environment with a high concentration of harmful gas (e.g. salty air, HCl, Cl2, SO2, H2S, NH3, and NOx)

(9) If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

(10) Mechanical stress during assembly of the board and operation has to be avoided.

(11) Pressing on parts of the metal cover or fastening objects to the metal cover is not permitted.
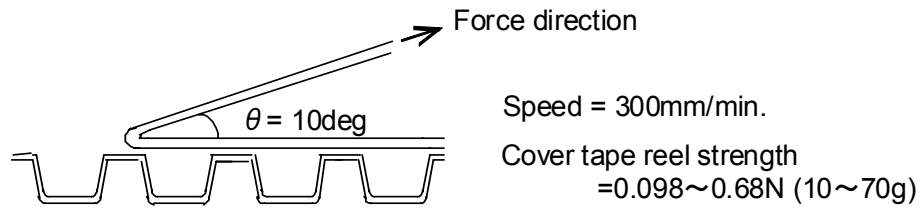
17.3 Storage Conditions

(1) The module must not be stressed mechanically during storage.

(2) Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance, may well be adversely affected:

(3) Storage in salty air or in an environment with a high concentration of corrosive gas, such as Cl2, H2S, NH3, SO2, or NOX

(4) Storage in direct sunlight

(5) Storage in an environment where the temperature may be outside the range of 5°C to 35°C range, or where the humidity may be outside the 45 to 85% range.

(6) Storage (before assembly of the end product) of the modules for more than one year after the date of delivery at your company even if all the above conditions (1) to (3) have been met, should be avoided.
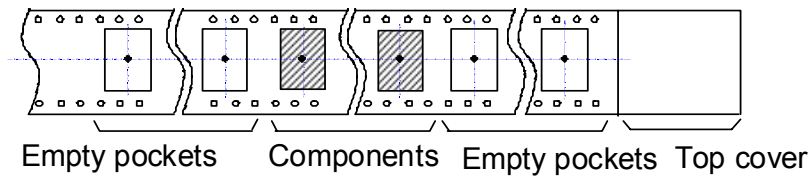
18 Packaging

18.1 Embossed Tape

(1) Dimension of the tape

   t.b.d.

(2)   Cover tape reel strength

Force direction

θ = 10deg

Speed = 300mm/min.

Cover tape reel strength
        =0.098～0.68N (10～70g)

(3)   Empty pockets

Empty pockets   Components   Empty pockets   Top cover

NB: Empty pockets in the component packed area will be less than two per reel and those empty pockets will not be consecutive.

18.2 Component Orientation

Top cover tape will not be found on reel holes and will not stick out from the reel

Direction

(top view)

Part No.

Component Orientation
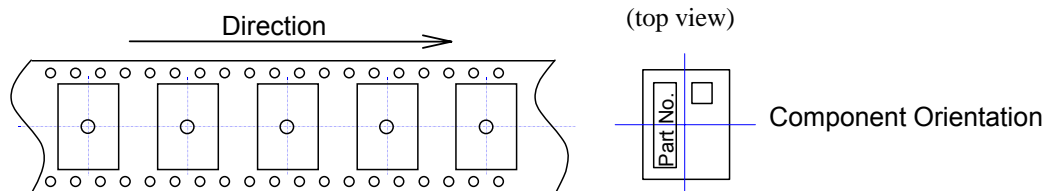
18.3 Reel Dimensions

(4)   Quantity per reel: 400 pieces

(5)   Marking: Part No. / Quantity / Lot No. and manufacturer part# with bar-code will be on the reel

t.b.d.

18.4 Packaging

(6)   Each reel will be packed in a hermetically-sealed bag

(7)   Marking :   Part No. / Quantity / Lot No. and manufacturer part# with bar-code

19 Ordering Information

Ordering/Product Code	Description
ETRX351 **ETRX357**	Telegesis Wireless Mesh Networking Module with Ember ZigBee® Technology: • Based on Ember EM351 or EM357 • Telegesis AT Style Command Interpreter and • EmberZNet3.xx meshing and self-healing ZigBee PRO stack • Integrated 2.4GHz Antenna
ETRX351HR **ETRX357HR**	Telegesis Wireless Mesh Networking Module with Ember ZigBee® Technology: • Based on Ember EM351 or EM357 • Telegesis AT Style Command Interpreter and • EmberZNet3.xx meshing and self-healing ZigBee PRO stack • U.FL Antenna Connector
ETRX3DVK	Telegesis Development Kit with: • T.b.d.

Notes:
- Customers' PO's must state the Ordering/Product Code.
- There is <u>no</u> "blank" version of the ETRX35x modules available. All Modules are pre-programmed with the Telegesis AT style command interpreter based on the EmberZNet stack. (Where customers wish to add their own firmware they can erase and write it to the flash memory of the EM35x).

20 Trademarks

All trademarks, registered trademarks and products names are the sole property of their respective owners.

21 Disclaimer

Product and company names and logos referenced may either be trademarks or registered trademarks of their respective companies. We reserve the right to make modifications and/or improvements without prior notification. All information is correct at time of issue. Telegesis (UK) Ltd does not convey any license under its patent rights or assume any responsibility for the use of the described product

22 RoHS Declaration

Declaration of environmental compatibility for supplied products:

Hereby we declare to our best present knowledge based on the declaration of our suppliers that this product does not contain the following substances which are banned by Directive 2002/95/EC (RoHS) or if they do, contain a maximum concentration of 0,1% by weight in homogeneous materials for:

- Lead and lead compounds
- Mercury and mercury compounds
- Chromium (VI)
- PBB (polybrominated biphenyl) category
- PBDE (polybrominated biphenyl ether) category

And a maximum concentration of 0.01% by weight in homogeneous materials for:

- Cadmium and cadmium compounds

23 Data Sheet Status

Telegesis (UK) Ltd. reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. Please consult the most recently issued data sheet before initiating or completing a design.

24 Life Support Policy

This product is not designed for use in life support appliances, devices, or systems where malfunction can reasonably be expected to result in a significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Telegesis (UK) Ltd. for any damages resulting.

25 Related Documents

[1]   IEEE Standard 802.15.4 –2003 Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)

[2]   Datasheet EM35x, Ember. (www.ember.com)

[3]   Datasheet U.FL-Series 2004.2 Hirose Ultra Small Surface Mount Coaxial Connectors - Low Profile 1.9mm or 2.4mm Mated Height

[4]   The ZigBee® specification (www.zigbee.org)

[5]   Specification for Antenova Rufa Antenna (www.antenova.com)

26 Contact Information

Website: www.telegesis.com
E-mail   sales@telegesis.com

Telegesis (UK) Limited
3, Abbey Barn Business Centre
Abbey Barn Lane
High Wycombe
Bucks
HP10 9QQ
UK

Tel: +44 (0)1494 510199

Fax: +44 (0)5603 436999